



# Advanced training school on Operation of Accelerators

June 3<sup>rd</sup> – 7<sup>th</sup>, 2024

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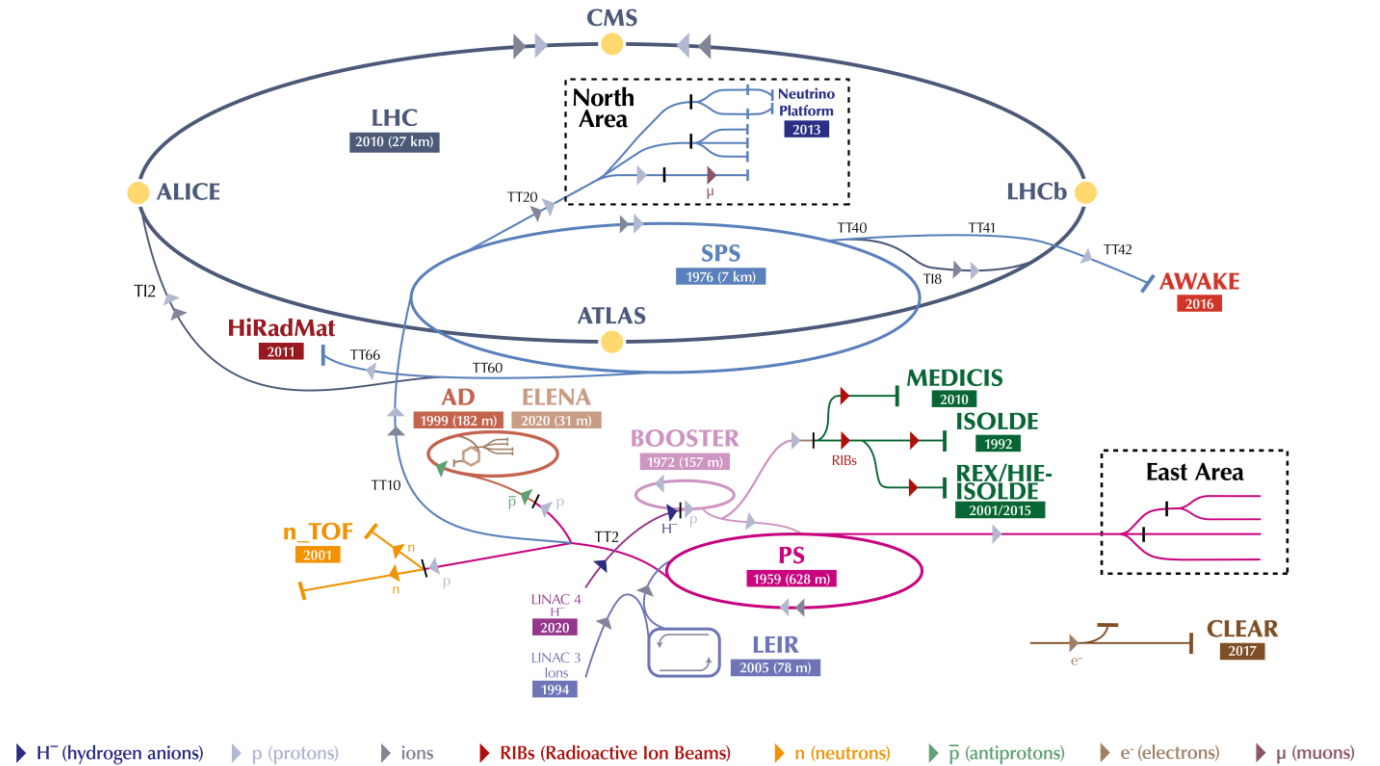


# CERN and its Accelerators

CERN Proton chain:

1. LINAC-4 160MeV (H-)
2. Proton Synchrotron Booster 2GeV
3. Proton Synchrotron 26GeV
4. Super Proton Synchrotron 450 GeV
5. Large Hadron Collider 7 TeV

The CERN accelerator complex  
*Complexe des accélérateurs du CERN*



LHC - Large Hadron Collider // SPS - Super Proton Synchrotron // PS - Proton Synchrotron // AD - Antiproton Decelerator // CLEAR - CERN Linear Electron Accelerator for Research // AWAKE - Advanced WAKEfield Experiment // ISOLDE - Isotope Separator OnLine // REX/HIE-ISOLDE - Radioactive Experiment/High Intensity and Energy ISOLDE // MEDICIS // LEIR - Low Energy Ion Ring // LINAC - LINear ACcelerator // n\_TOF - Neutrons Time Of Flight // HiRadMat - High-Radiation to Materials // Neutrino Platform

# What we have done this week

Monday-Tuesday



CLEAR

Wednesday



PSB

Thursday-Friday



ISOLDE



## Content

Accelerator Complex  
Control system  
Beam characterization  
Phasing SC Cavities  
Mass Scans  
Steering Algorithms  
Other advances Topics



## Facilities

CLEAR  
PS Booster  
ISOLDE



## Our Fields

Nuclear Physics  
Detectors  
Engineering  
Radiobiology  
Accelerator Diagnostics





Centre for Microanalysis of Materials  
(CMAM)

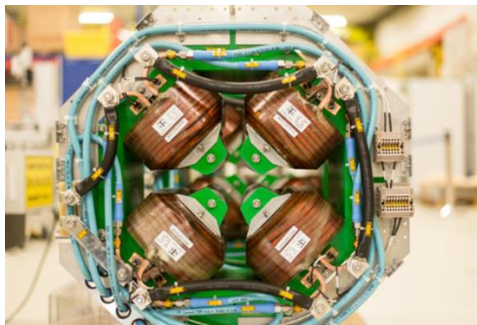


Institute for the Structure of Matter  
(IEM-CSIC)

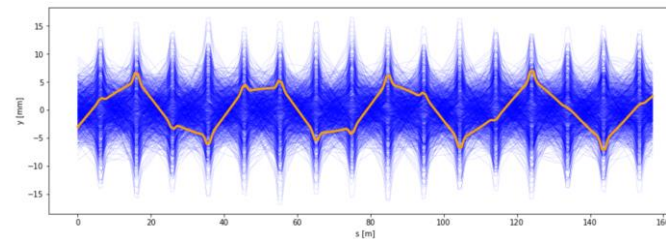
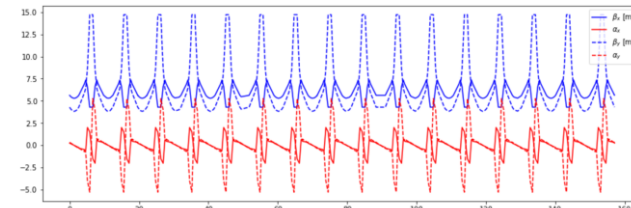
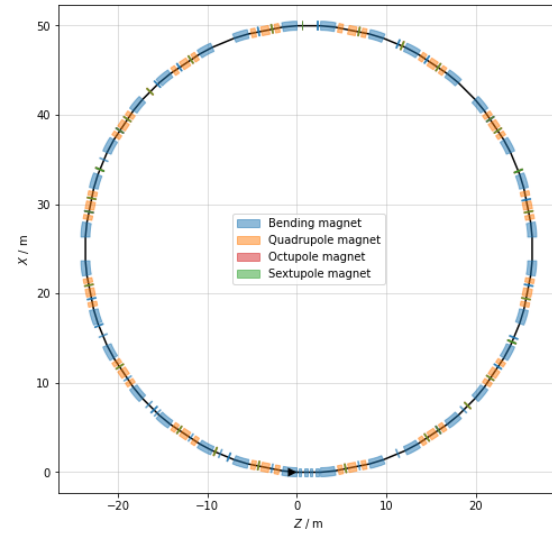


ISOLDE Decay Station  
(IDS)

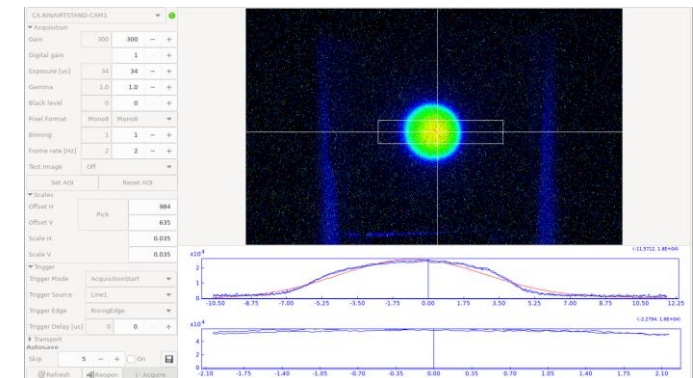
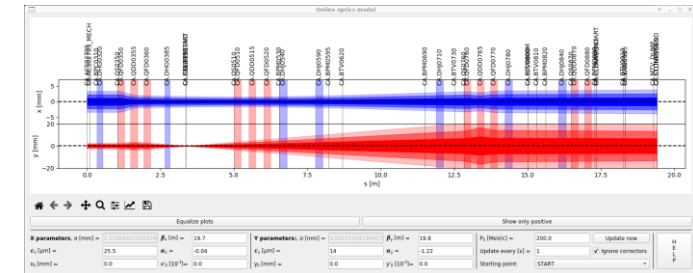
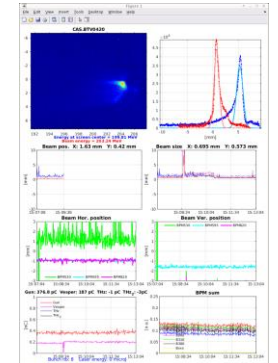
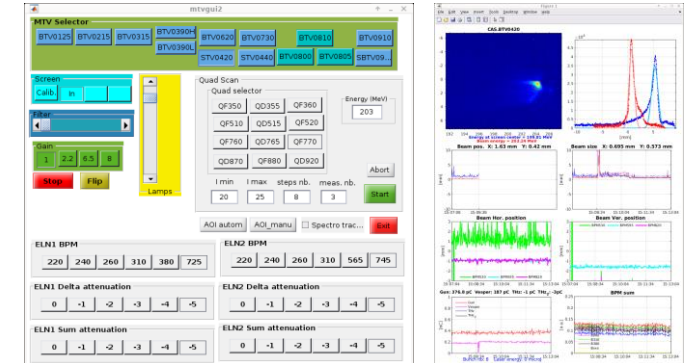
# Accelerator Instrumentation



# Simulation and beam design



# Operation and beam tuning

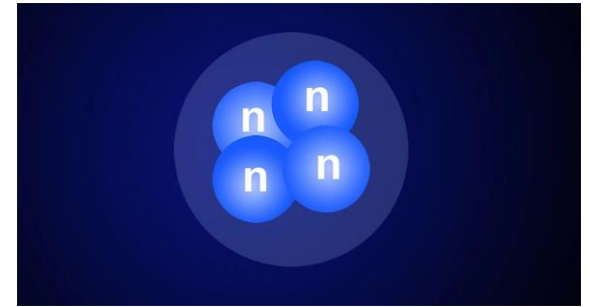




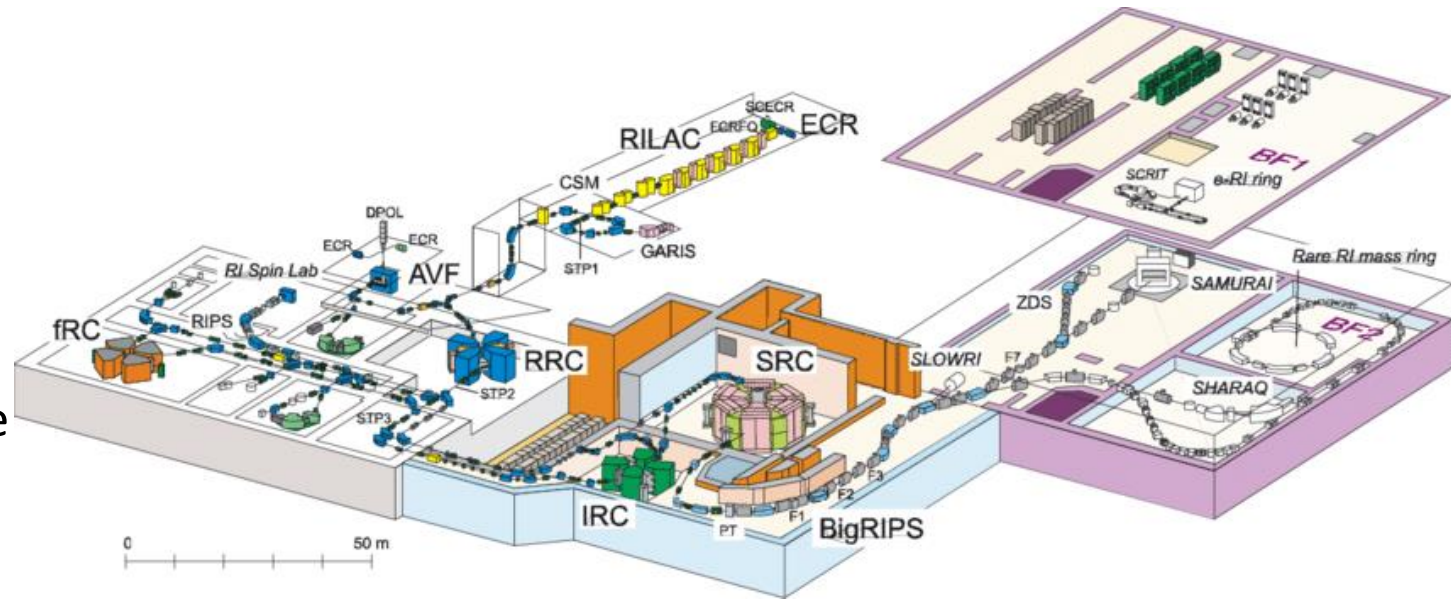
# ATSOA 2024: Audrey ANNE



- Personal background:  
Master's degree in Nuclear Physics at Caen University, France (2021-2023)  
Ph.D Thesis 1st year: multineutron correlation in the decay of heavy helium isotopes

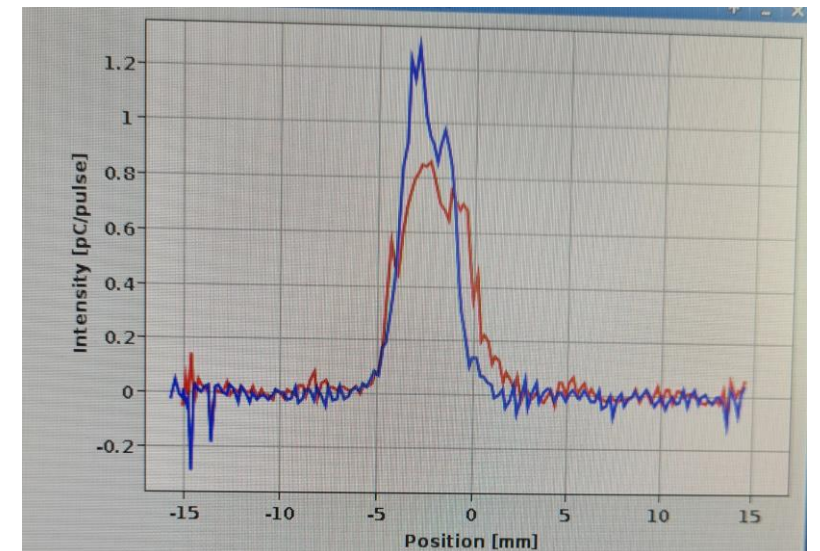
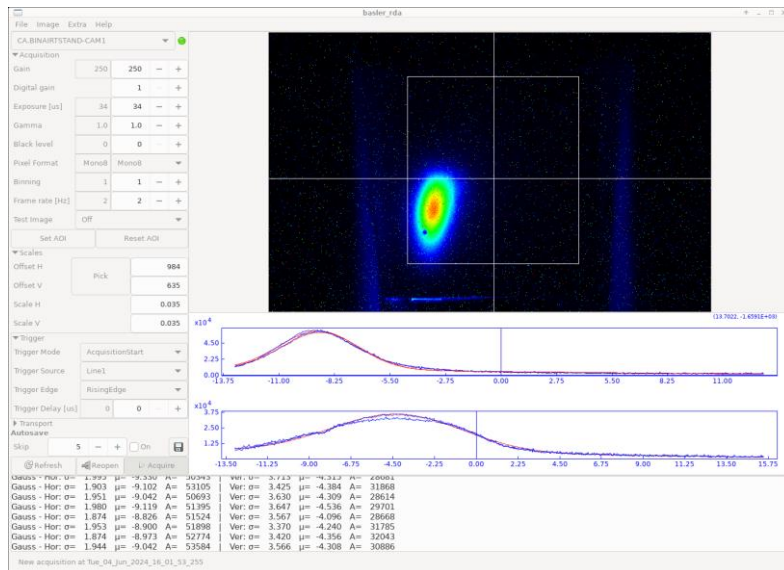
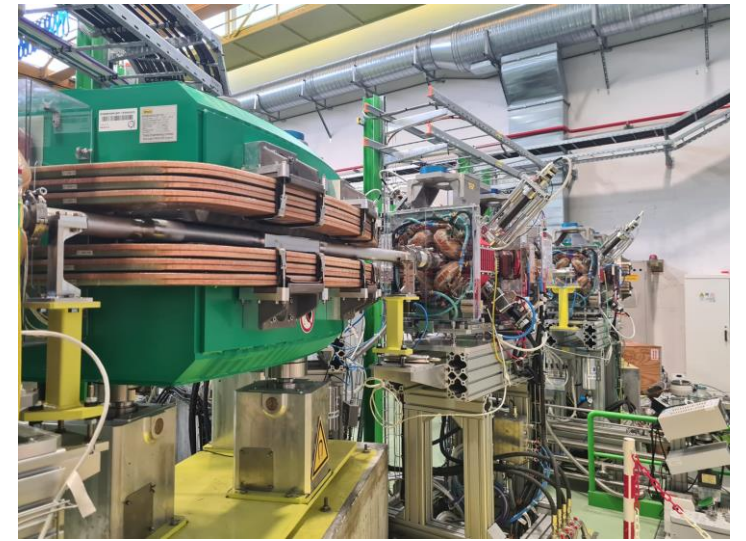


- Accelerator background:  
Little knowledge of radioactive production by fragmentation reaction (BigRIPS at RIKEN, Japan) and cyclotron
- What I wanted to see:  
ISOLDE : another way to produce radioactive ion beams



# Personal Highlights

- In general:
  - Discovery of different beam production techniques
  - Using real beams
  - Learned more about accelerator instrumentation
- For each facility
  - CLEAR: Learning about the flash effect, tuning every parameter and seeing the effect
  - PSB: applying what we saw in lectures at this facility, visiting the control room
  - ISOLDE: the visit and seeing every step of the beam production





# ATSOA (Hannes' version)

First year Master Student User at ISOLDE:

- Bachelor in physics with biology focus
- Perturbed Angular Correlation on Domain walls in  $\text{LiNbO}_3$
- No accelerator physics background.
- Nuclear physics background and experience with Beam Accelerator Operation at ISOLDE

Expected:

- Learn about the operation, functionality  
Physics of Beam accelerators.

Spoiler: This was totally fulfilled!  
Although the short time.



# Personal Highlights

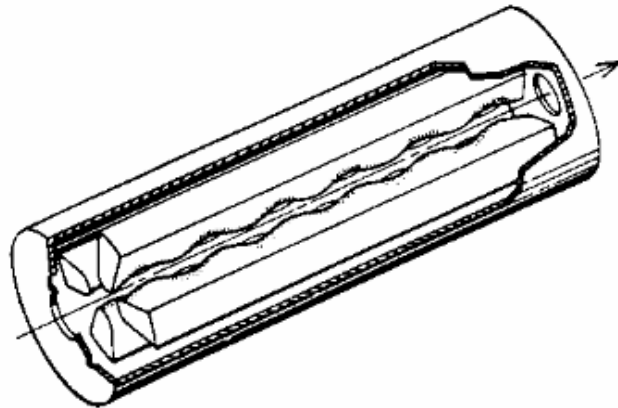
Beam physics concept of emittance,  $\beta$ eatrons and stable regions

Personal favorites:

Clear: Quadrupole tuning, beam steering, FLASH-effect

PSB : Testing out periodicity areas and seeing the emittance and intensity drop

ISOLDE: mechanism, Radiofrequency Quadrupoles, beam production



Concluding:

**Amazing Time Spent on Accelerators**

Normal People



Physicists





# Hands-on Training School on Acceleration Operation (Yuliia Komar)

## Education:

- Master degree at the Taras Shevchenko National University of Kyiv Educational and Scientific Center "Institute of Biology and Medicine" (2022-2024)
- Master of Biochemistry at the Freie Universität Berlin, Germany (2022-...)

## Topic of interest:

- FLASH radiotherapy for cancer treatment

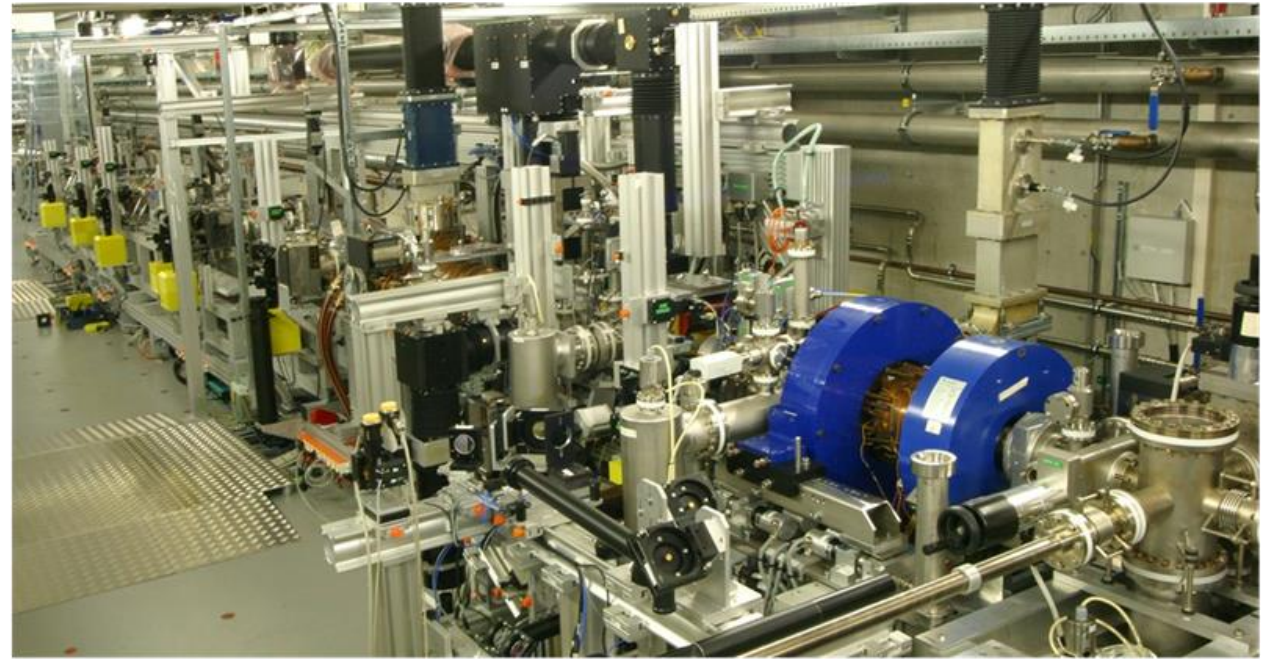
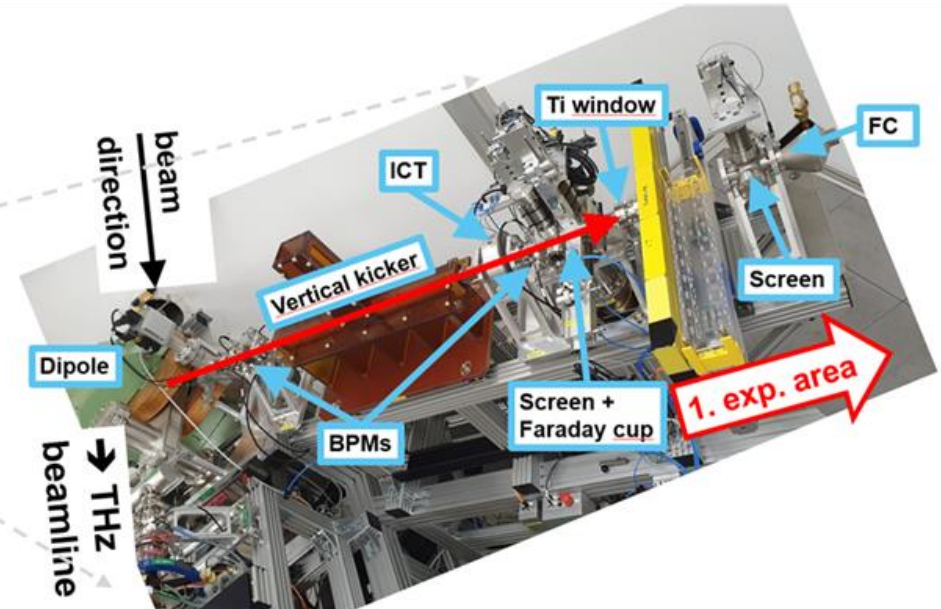
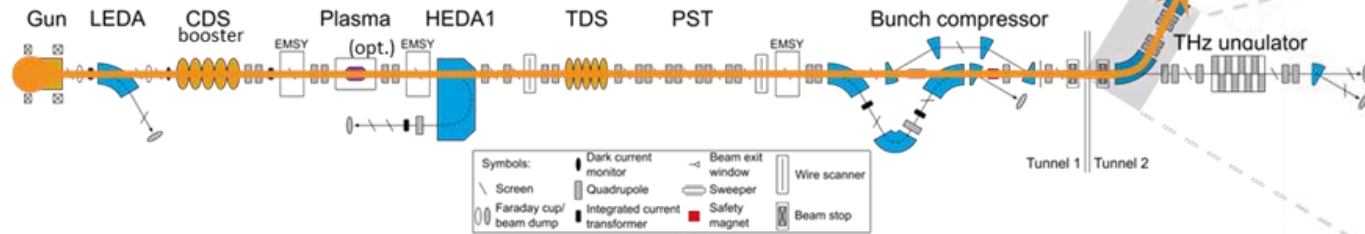


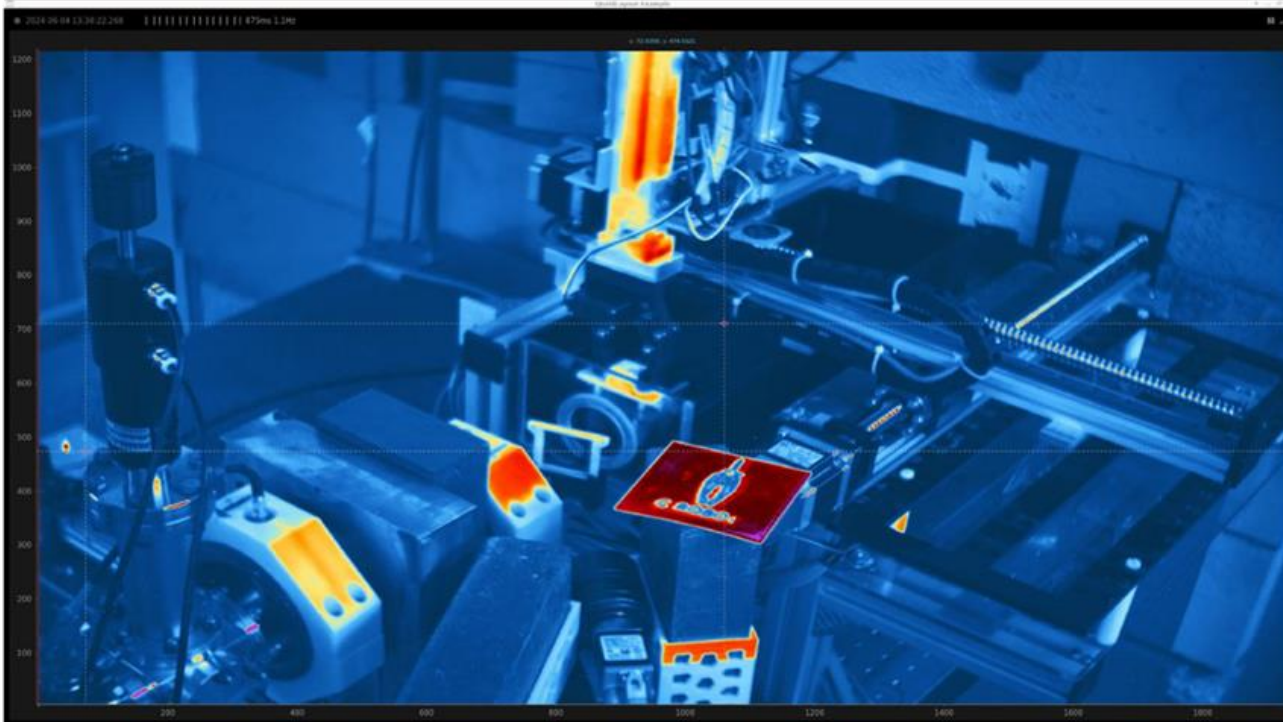
Photo Injector Test Facility at DESY, Zeuthen (Germany)



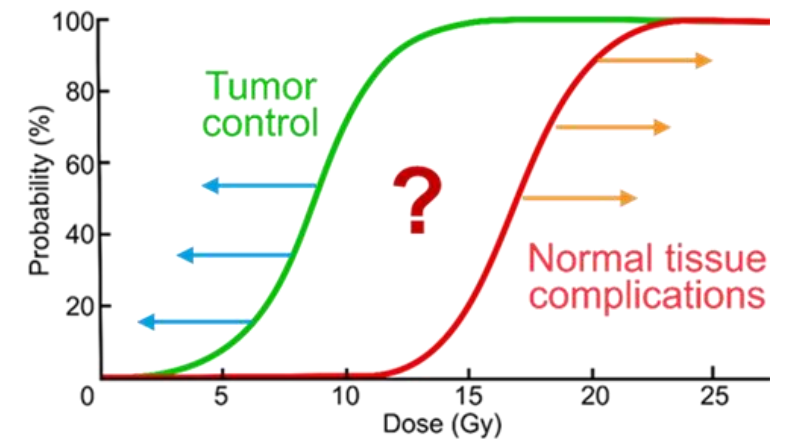


## Personal highlights

- Get a general insight into the structure and functionality of various accelerators, beam production etc.
- Get an overview of how to operate an accelerator and measure main parameters of a beam
- Set a beam for sample irradiation with ultra-high dose rate
- Parameters of beam needed for irradiation with ultra-high dose rate
- Observe the irradiation setup at CLEAR



$\leq 10^{14}$  Gy/s

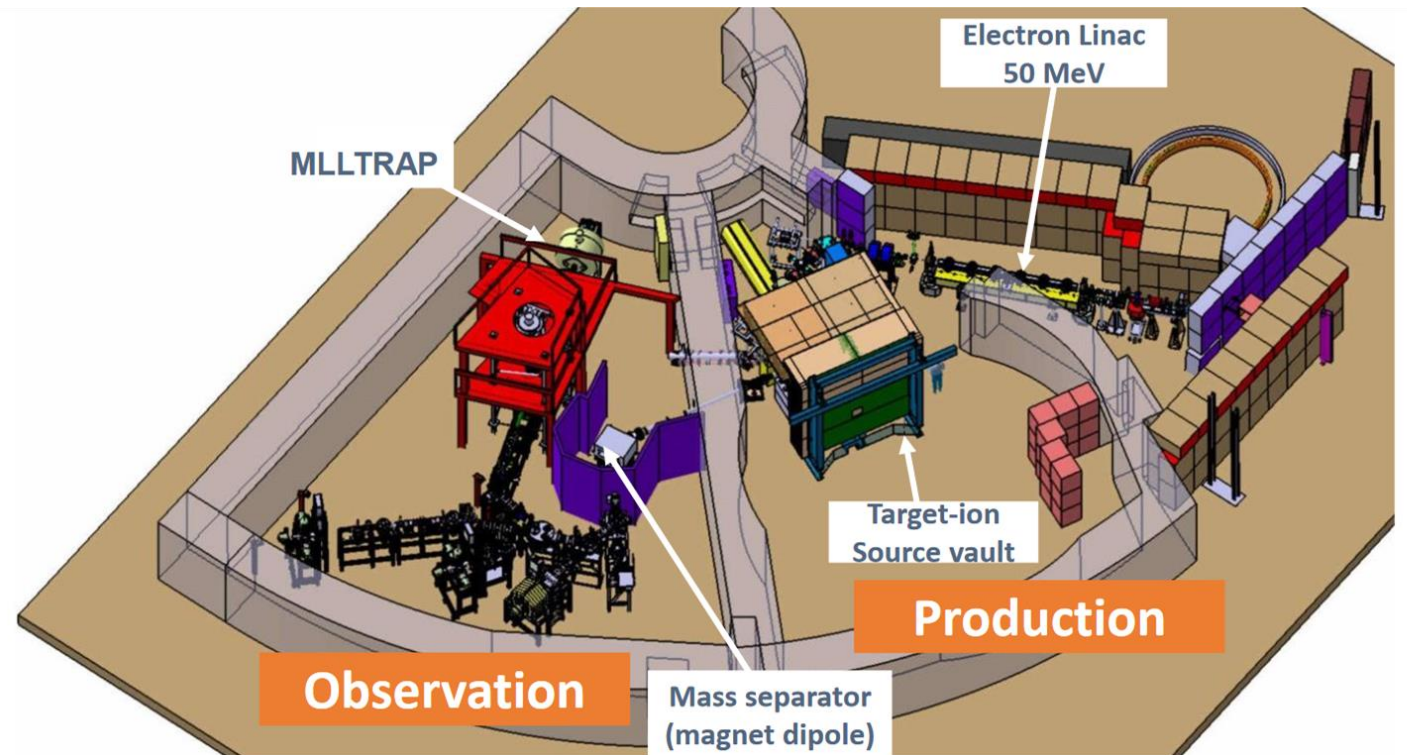
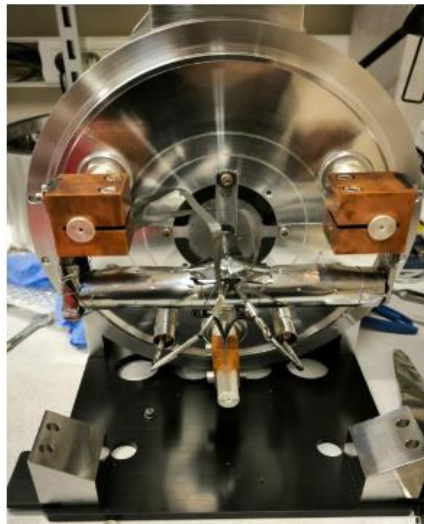


$10^{14}$  Gy/s

*Courtesy of Dr. Anna Grebinyk*

# Florian: Personal background

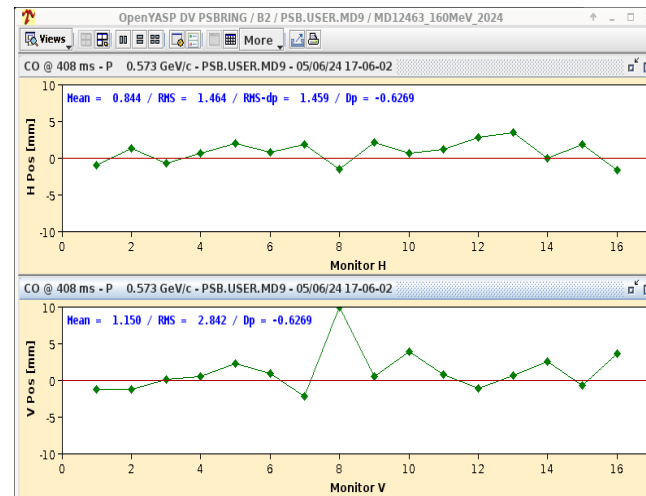
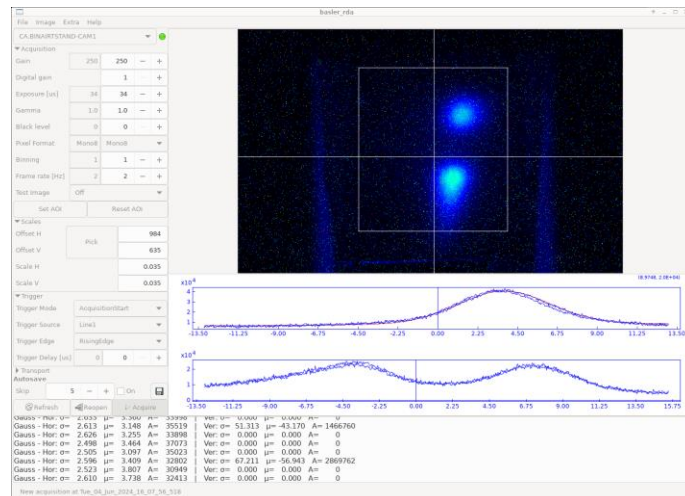
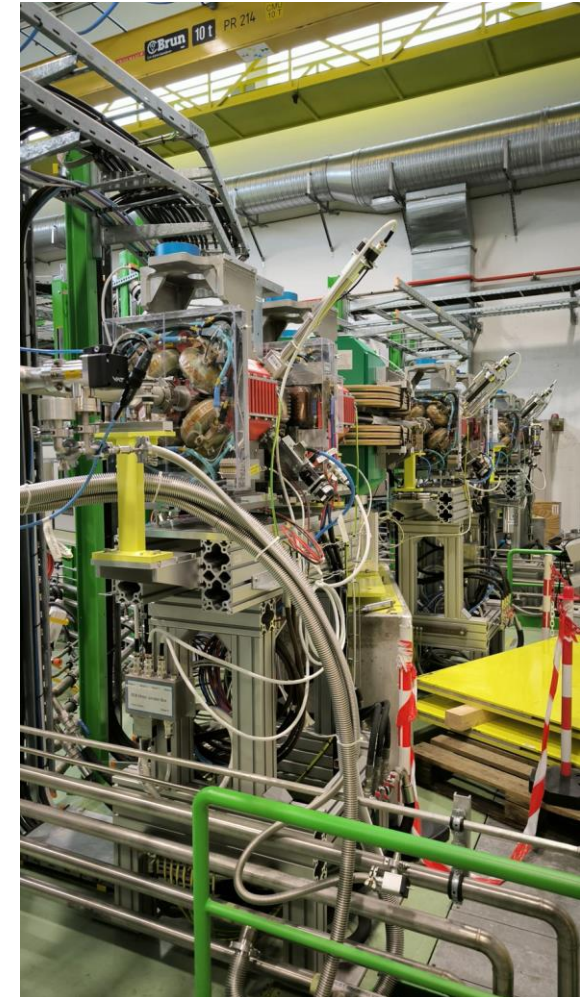
- Master GI (large facilities)
- Work at ALTO IJCLab since 2020
- Manager of the LEB (Low Energy Beam)





# Florian: What I bring home

- New approach on different way of work on accelerators
- Clear : Home made and passion
- PSB : Impressive and kind of historic
- ISOLDE: New way to understand my daily work

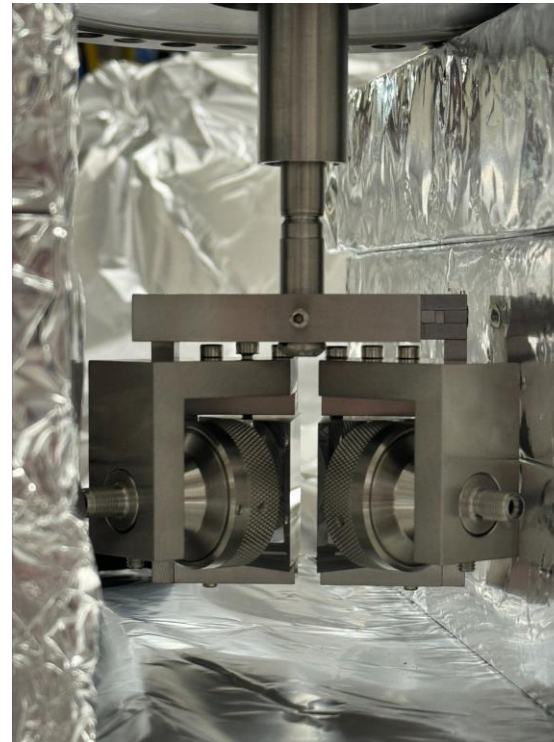




# Alec's Background

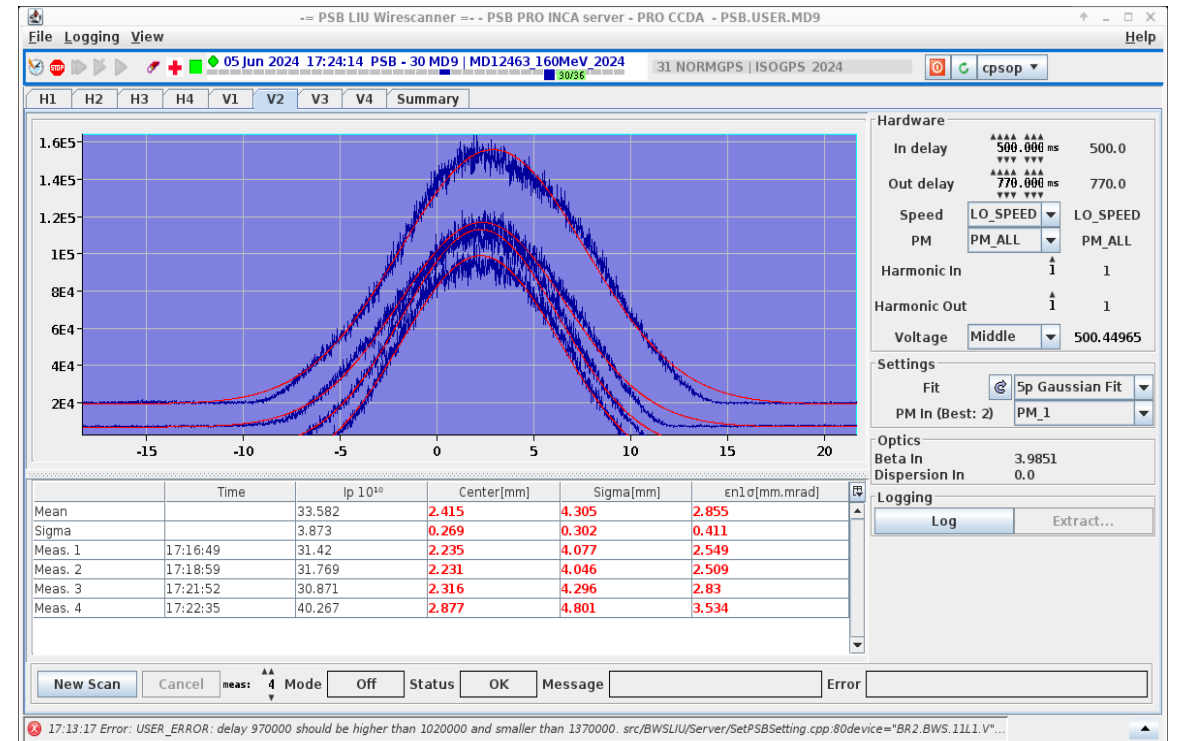
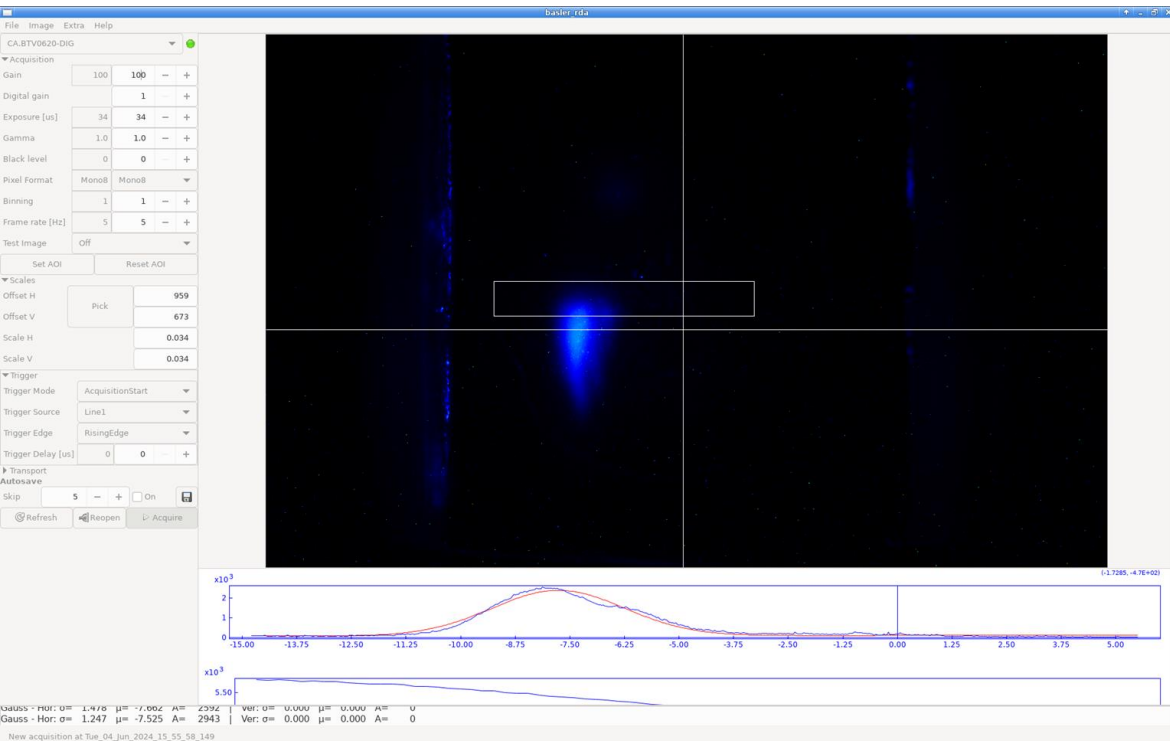


- Third year PhD student split between Royal Holloway and Diamond Light Source
- PhD project: incoherent Cherenkov diffraction radiation based beam position monitor
- Research interests: beam diagnostics & radiation applications
- What I hoped to see: how different accelerator operation is for the different machines and the diagnostic tools used



# Personal Highlights Of ATSOA

- Getting to play with the beams
- Seeing Clear and Isolde “in the flesh”
- The guided introduction to xsuite
- Seeing all the diagnostics tools in action across the three machines
- Learning about “FLASH” & “Spatially Fractionated RT”
- Learning about RFQ’s





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